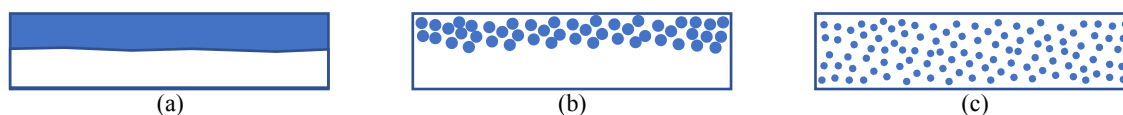


PhD subject proposal  
**Experimental study of sheared water-in-oil concentrated emulsions:  
dynamics, topology, rheology and scaling laws**  
CIFRE grant (Total/LGC & IMFT).

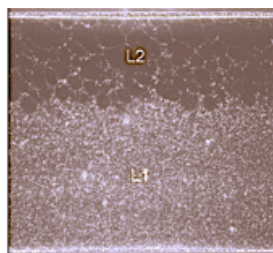
Two-liquid phase flows in horizontal or inclined pipes take place in many processes of petroleum, pharmaceutical, chemical or food industry. Depending on the hydrodynamic regime, the entry conditions and the interface properties, the topology of the liquid phases may be subject to significant changes. A phase-separated stratified flow is observed at low flowrate (fig. 1a), whereas at high flowrate, a fully dispersed flow of water droplets in oil (or of oil droplets in water) develops (fig. 1c). In between, dispersed and stratified flows coexist in various configurations (fig. 1b and image of fig.2). Each configuration involves a specific flow, the characterization of which is an important issue, in particular in view of predicting the pressure gradient along the pipe.



**Figure 1. (a) Separated flow, (b) dispersed-stratified flow, (c) fully dispersed flow**

In this PhD thesis, it is proposed to study the local structure of a dispersed-stratified flow of an emulsion in a plane Couette device. In addition to its generic nature, this setup allows the study of the flow features and phase distribution over long times. In the homogeneous dispersed-flow configuration, it can be used to characterize the rheology of the emulsion in a wide range of concentration, from the dilute case to the glass transition and beyond.

The studied system consists of a water-in-oil emulsion. Under the action of gravity, a dispersed-stratified flow develops, constituted of a dense zone of water droplets dispersed in oil topped by a layer of oil free of droplets. Matching the refractive index of both phases will allow the implementation of optical measurement techniques, such as Particle Image Velocimetry (PIV), Optical Flow and Laser-Induced Fluorescence (LIF). For a given system of liquids, the flow control parameters are the volume fraction of droplets and the imposed shear rate. The addition of amphiphilic molecules (or particles) will allow the study of the influence of the interface rheology upon the distribution of phases and the flow dynamics.



**Figure 2. Visualization of a stratified-dispersed oil-in-water flow in a horizontal pipe by a laser sheet in a matched refractive index medium. Conan et al. AIChE Journal, 53, 11, 2754–2768 (2007). <https://doi.org/10.1002/aic.11309>**

This experimental study will lead to the establishment of a physical model predicting the evolution with time of a sheared water-in-oil emulsion: phase distribution, effective rheology and dissipation of energy. From a more general perspective, such a model will be valuable in view of optimizing the processes involving flows of dense emulsions. For TOTAL company, it is also expected that this model will contribute to reduce carbon footprint in the transport of crude-oil emulsions.

This PhD thesis will take place at the Laboratoire de Génie Chimique of Toulouse in collaboration with the Institut de Mécanique des Fluides de Toulouse. Financial support will be provided by TOTAL company and a CIFRE grant.

Desired profile of the candidate:

The candidate will be holder of a Master degree in Fluid Mechanics, Chemical Engineering, Complex Fluids or Soft Matter. A good knowledge of experimental techniques in Fluid Mechanics is a plus.

Supervisors and contact persons for the application:

LGC: Olivier Masbernat ([olivier.masbernat@ensiacet.fr](mailto:olivier.masbernat@ensiacet.fr)); IMFT: Frédéric Risso ([frisso@imft.fr](mailto:frisso@imft.fr)); TOTAL: Roel Belt ([roel.belt@total.com](mailto:roel.belt@total.com)).

Annual gross salary: 37 k€

**Starting in October 2020, duration: 3 years.**